

CLAIMS

What is claimed is:

1. A solid-state sensor device for sensing acceleration along a specific direction, comprising:

5 a substrate containing a cavity;
 a mass being disposed in the cavity;
 a thin film toroidal support membrane disposed on the mass; and
 a plurality of thin film piezoelectric elements disposed on the support
membrane and arranged to generate an electrical signal upon accelerating the sensor
10 device along the specific direction.

2. The solid-state sensor device of claim 1 wherein the thin film piezoelectric elements are arranged in differential pairs.

3. The solid-state sensor device of claim 2 wherein area of each thin film piezoelectric element in each differential pair is the same.

15 4. The solid-state sensor device of claim 3 wherein a differential pair of thin film piezoelectric elements has an identical mirror image pair with respect to a plane through a center of the mass.

 5. The solid-state sensor device of claim 3 wherein a differential pair of thin film piezoelectric elements has an identical mirror image pair with respect to a 180
20 degree rotation around a center of the mass.

6. The solid-state sensor device of claim 3 wherein the differential pairs of thin film piezoelectric elements are identical through any combination of 180 degree rotations and mirror images through a set of orthogonal planar axes.

5 7. A solid-state rotational rate sensor device for sensing rotational rate around a first direction upon actuating the device along a second direction, comprising:

a substrate containing a cavity;

a mass being disposed in the cavity;

a thin film toroidal support membrane disposed on the mass;

10 a first set of thin-film piezoelectric elements disposed on the support membrane and arranged to generate an electrical signal upon accelerating the sensor device along the first direction; and

a second set of thin-film piezoelectric elements disposed on the support membrane and arranged to generate a motion along the second direction.

15 8. The solid-state sensor device of claim 7 wherein the first and/or second thin film piezoelectric elements are arranged in differential pairs.

9. The solid-state sensor device of claim 8 wherein area of each thin film piezoelectric element in each differential pair is the same.

20 10. The solid-state sensor device of claim 9 wherein a differential pair of thin film piezoelectric elements has an identical mirror image pair with respect to a plane through a center of the mass.

11. The solid-state sensor device of claim 9 wherein a differential pair of thin film piezoelectric elements has an identical mirror image pair with respect to a 180 degree rotation around a center of the mass.

5 12. The solid-state sensor device of claim 9 wherein the differential pairs of thin film piezoelectric elements are identical through any combination of 180 degree rotations and mirror images through a set of orthogonal planar axes.

13. A solid-state actuator device for generating motion along a specific direction, comprising:

10 a substrate containing a cavity;
a mass being disposed in the cavity;
a thin film toroidal support membrane disposed on the mass; and
a plurality of thin film piezoelectric elements disposed on the toroidal support membrane and arranged to generate motion along the specific direction upon applying an electrical signal.

15 14. The solid-state actuator device of claim 13 wherein the thin film piezoelectric elements are arranged in differential pairs.

15. The solid-state actuator device of claim 14 wherein area of each thin film piezoelectric element in each differential pair is the same.

20 16. The solid-state actuator device of claim 15 wherein a differential pair of thin film piezoelectric elements has an identical mirror image pair with respect to a plane through a center of the mass.

17. The solid-state actuator device of claim 15 wherein a differential pair of thin film piezoelectric elements has an identical mirror image pair with respect to a 180 degree rotation around a center of the mass.

5 18. The solid-state actuator device of claim 15 wherein the differential pairs of thin film piezoelectric elements are identical through any combination of 180 degree rotations and mirror images through a set of orthogonal planar axes.